

Reinforced Polypropylene (fPP-R) GUIDE SPECIFICATIONS

FLEXIBLE POLYPROPYLENE – REINFORCED (fPP-R)

PART 1. GENERAL

1.1 SCOPE OF WORK

The work covered by this specification consists of providing and installing a scrim reinforced flexible polypropylene (fPP-R) sheet for use as a geomembrane liner.

1.2 SUBMITTALS TO OWNER OR OWNER’S REPRESENTATIVE

- A. Sheet Layout and Detail Drawings: The fabricator/installer must submit geomembrane panel layout, anchor trench and penetration detail drawings a minimum of 30 days prior to delivery of the’s fPP-R geomembrane to jobsite.
- B. Record “As-Built” Drawings: The fabricator/installer must submit final record “As-Built” drawings of geomembrane installation showing panel/sheet numbers, seam numbers, and location of patches, destructive and /or non-destructive seaming samples, and any penetrations.
- C. Other Submittals:
 - 1. The fabricator/installer shall submit the manufacturer’s specifications and details.
 - 2. The installer shall submit certification of the acceptability of the substrate on which the the’s fPP-R geomembrane is to be placed prior to the geomembrane placement.
 - 3. The fabricator/installer shall submit one sample measuring 12” x 12” of the appropriate thickness of the fPP-R geomembrane with one welded seam.

1.3 QUALITY ASSURANCE

- A. The must possess a minimum of five years or more experience in the manufacturing of geomembranes for the purpose of general containment linings.
- B. Factory Fabrication
 - 1. The in-house fabricator shall be an experienced firm customarily engaged in factory-fabricating individual widths of scrim-reinforced geomembrane roll stock into large panels. The fabricator shall have experience in fabricating a minimum of 1,000,000 square feet of geomembrane by thermal fusion methods or hot air.

2. The installer is responsible for field handling, deploying, seaming, anchoring, and field quality control testing of the manufacturer's fPP-R geomembrane and shall have installed a similar geomembrane material. At least one of the installation crew shall have experience equal to the seaming of a minimum of 100,000 square feet of the manufacturer's fPP-R geomembrane material.

1.4 DELIVERIES, STORAGE AND HANDLING

- A. The fPP-R geomembrane should be protected from punctures, abrasions, vandalism, excessive heat or cold or other damaging conditions.
- B. Each panel supplied by the fabricator shall be rolled and/or accordion folded and placed onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each panel shall be given prominent and unique identifying markings indicating the proper direction of unrolling and/or unfolding to facilitate layout and position in the field. The panels shall be suitably packaged, enclosed and protected to prevent damage during shipment and each package shall be prominently marked in the same fashion. Until needed, packaged factory fabricated panels shall be stored in their original unopened containers in a dry area, and protected from the direct heat of the sun, where possible. Do not use damaged materials. Remove damaged fPP-R geomembrane from the project site at no additional cost to the owner.
- C. The fPP-R geomembrane shall be delivered to the project site intact and free from any tears, abrasion, or damage.

1.5 SITE INSPECTION

- A. The installer shall visit the site to check whether the excavation work has been performed as per the contract agreement.
- B. In no event shall the fPP-R geomembrane be placed over rocks or other materials, which are capable of puncturing or stressing the fPP-R geomembrane. In some instances, a protection geotextile should be installed under the fPP-R geomembrane. The project engineer should determine the type and mass per unit area of the geotextile. In the absence of a project engineer, the installer should determine the type and mass per unit area of the geotextile. The ground surface shall be free of all organic debris and sharp objects before placement of the The fPP-R geomembrane. The fPP-R geomembrane shall be overlapped and field-seamed when the fPP-R geomembrane and substrate is dry.

PART 2 PRODUCTS

2.1 MATERIALS – Flexible, reinforced polypropylene (fPP-R)

TYPICAL fPP-R PROPERTIES AND CHARACTERISTICS			
Physical Property	Test Method	Property Of Unaged Sheet	Property After Aging 30 days @ 185 F
Tolerance on nominal thickness, %	ASTM D 5199	± 10	
Thickness over scrim, in. (mm) 36-mil 45-mil 60-mil	ASTM D 4637 Optical Method	0.010 (0.254) min. 0.013 (0.330) min. 0.018 (0.457) min.	
Mass per unit area, lb/ft ² (g/ ft ²) (kg/m ²) 36-mil 45-mil 60-mil	ASTM D 5261	0.17 (77) (0.83) typical 0.21 (95) (1.03) typical 0.29 (132) (1.42) typical	
Breaking strength, lbf (kN) (grab tensile at strain rate of 12 in./min.) 36-mil 45 & 60-mil	ASTM D 751 Grab Method A	200 (0.9) min. 260 typ. 250 (1.1) min. 300 typ.	200 (0.9) min. 260 typ. 250 (1.1) min. 300 typ.
Elongation at break of fabric, %	ASTM D 751	25 typical	25 typical
Tearing strength, lbf (N) (2 in. / min. strain rate) 36-mil 45 & 60-mil	ASTM D 5884 (max. load)	80 (356) min. 130 (578) typ. 100(445) min. 160 (712) typ.	
Low temperature flexibility, °F (°C)	ASTM D 2136 1/8 in. mandrel 4 hour @ temp.	- 40 (- 40) max. - 50 (- 46) typical	
Linear Dimensional Change (shrinkage), %	ASTM D 1204		+/- 1.0 max. - 0.5 typical
Ozone resistance, 100 pphm, 168 hours	ASTM D 1149	No cracks	No cracks
Resistance to water (distilled) absorption After 30 days immersion 122 °F (50 °C) Change in mass, %	ASTM D 471 (coating compound)	1.0 max. 0.5 typical	
Hydrostatic resistance, lbf/in. ² or psi (MPa) (Mullen burst) 36-mil 45-mil 60-mil	ASTM D 751 Procedure A	350 (2.4) min. 400 (2.8) typical 450 (3.1) typical 500 (3.4) typical	350 (2.4) min. 400 (2.8) typical 450 (3.1) typical 500 (3.4) typ.
Field seam strength, lbf/in. (kN/m) Seam tested in peel after weld	ASTM D 4437 1 in. wide	30 (5.3) min. 60 (10.5) typical	
Water vapor permeance, Perms	ASTM E 96	0.10 max. 0.05 typical	
Puncture resistance, lbf (N) 36-mil & 45-mil 60-mil	ASTM D 4833 (index puncture)	85 (378) min. 110 (489) typical 120 (534) typical	
Resistance to xenon-arc weathering ¹ Xenon-Arc, 15,120 kJ/m ² total radiant exposure, visual condition at 10X	ASTM G 155 0.70 W/m ² 80 °C B.P.T.	No cracks No loss of breaking or tearing strength	
1 Equivalent to 12,000 hours exposure at 0.35 W/m ² irradiance		B.P.T. is black panel temperature	3/06

Note: Accessories shall be as supplied by the geomembrane manufacturer.

2.2 WARRANTY

Upon notice of completion from the installer and acceptance by the manufacturer a written fPP-R limited material warranty shall be issued.

PART 3 EXECUTION

3.1 FACTORY FABRICATION, INSPECTION AND TESTING

- A. Prior to factory seaming, all roll goods shall be inspected. All factory seams shall be made by thermal fusion methods or hot air. All factory seams shall have a minimum scrim to scrim overlap of one and one half inches when fabricated. Fabricated seams found to have less than the specified overlap shall be repaired by adding an overlap or cap strip that provides the minimum specified overlap or it will be rejected. All seams shall be made so that thermal fusion bond extends fully along the width of the sheet so that no loose edges are present.
- B. All sheets and seams shall be visually inspected during fabrication. No defective seams or exposed scrim will be allowed. All exposed scrim edges shall be sealed with an extrusion weld. All indicated repairs shall be made by the geomembrane fabricator before the panels are packaged for shipment.
- C. In addition to visual inspection, a 4 foot (1.2m) weld sample shall be made with each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Samples shall be taken from a seam specifically made for quality testing and not taken from the fabricated panel itself. Test specimens shall be cut in one foot lengths from the each specimen and tested for shear strength and peel adhesion. The shear and peel strength shall be tested in accordance with ASTM D6392.
- D. A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. The fabricator shall provide the test results to the Owner or Engineer upon request.
- E. Prior to installation of the fPP-R geomembrane, the fabricator or installer shall provide the engineer with the following certification and test reports:
 - 1. Written certification that the materials meet the material property requirements in the product specification Section 2.1 of this specification.
 - 2. Written certification that the factory seams were inspected and tested in accordance with ASTM D6392.

3.2 SUBGRADE PREPARATION

- A. Surface Preparation: Perform in accordance with project specifications. Loose rock larger than one half inch in diameter and other debris that could damage the fPP-R geomembrane shall be removed from the substrate. Construction equipment track deformations shall not be greater than one inch in depth. Installer shall observe subgrade surface daily and shall evaluate the surface conditions for the installation of the fPP-R geomembrane. Before installing the fPP-R geomembrane, the installer shall certify in writing to the owner that the substrate upon which the the's fPP-R geomembrane is to rest is acceptable.
- B. Anchor Trenches: On a daily basis excavate only the length of anchor trench, which can be overlain with the fPP-R geomembrane and properly backfilled. Anchor trench corners toward the containment shall be rounded and free of protrusions to avoid sharp bends in the fPP-R geomembrane. Loose soil, rocks larger than one half inch in diameter, and other debris that could damage the fPP-R geomembrane shall be removed from upper edge of trench toward the containment. Backfill anchor trench material shall meet the same requirements as the substrate.

3.3 THE fPP-R GEOMEMBRANE PLACEMENT

- A. The fPP-R geomembrane shall be placed with a minimum of handling and in accordance with the approved shop drawings. All procedures and equipment shall ensure that no damage occurs to the fPP-R geomembrane. Any fPP-R geomembrane damaged during installation shall be removed or repaired by the installer as specified in section 3.5 of this specification. Any replacement work required by this specification will be completed at no additional cost to the owner. Daily installation is limited to the number of the fPP-R geomembrane panels that can be anchored and seamed together on the same day without damaging the fPP-R geomembrane and with placement of adequate ballast on the fPP-R geomembrane to prevent, wind-uplift. The method or equipment used to unroll or place geomembrane panels shall not stress or damage the geomembrane. All seams shall run parallel to the line of MAXIMUM slope or they must rest without tension in the bottom of the containment.

3.4 FIELD SEAMING

- A. Lap joints shall be used to seal factory fabricated sheets together in the field. The lap joint shall be formed by lapping the edges of the sheets four to six inches. The contact surfaces of the sheet shall be wiped clean of all dirt, moisture and other foreign material. A minimum of one and one half inch bond shall used for all field seams. A minimum of two inches shall be used to join all floating cover field seams.

- B. Avoid fishmouths, wrinkles, folds or pleats in the seam area. Where fishmouths do occur, they shall be slit out far enough from the seam to dissipate them, lapped, seamed together in the lapped area and patched. Any necessary repairs to the fPP-R geomembrane shall be done using an additional piece of the specified geomembrane applied as stated in Section 3.5 of this specification. All patching material shall have rounded corners.
- C. Cleanup on the project shall be an ongoing responsibility of the installer. Particular care should be taken to ensure that no stones, scrap material, trash, tools or other unwanted items are trapped beneath the geomembrane.
- D. All field seams shall be made utilizing hot air or hot wedge welding techniques in accordance with industry standards.
- E. Cold Weather Seaming
 - 1. Extra care must be taken when seaming in cold weather. For ambient temperatures below 35°F some means of preheating the liner may be necessary. It is critical that adjustments are made and non destructive testing should be completed to a test weld prior to any field seam welding. Details of the preheat (space heaters, temporary shelters and combinations of the two) will be determined by the individual job conditions. The following variables are measured and recorded:
 - a. Liner temperature (surface contact thermometer)
 - b. Ambient temperature (6" above geomembrane)
 - c. Wedge welder temperature during welding
 - d. Wedge speed
 - e. Temperature set point of wedge welder
 - 2. The wedge welder temperature during the welding must be observed and recorded. After starting a seam the temperature is observed and recorded every 20 feet for the first 60 feet or until the wedge welder temperature appears to have stabilized. After the temperature has stabilized the wedge welder temperature is observed and recorded every 15 minutes.
 - 3. No welding can take place when it is snowing, sleeting or raining. Snow and ice must be removed from the geomembrane prior to any welding. Snow removal is the responsibility of the owner or contractor. Snow blowers are typically used to remove the top portion of snow leaving the

lower 2 to 3 inches above the liner. The remainder of the snow shall be removed by hand using plastic shovels or brooms.

3.5 FIELD SAMPLING AND TESTING

- A. Non-Destructive Testing: Upon completion of the liner installation, all seams shall be visually inspected for compliance with these specifications. In addition to the visual inspection, all field seams shall be non-destructively tested over their full length in accordance with ASTM D 4437 (high pressure air lance) to ensure seam continuity. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Seams that fail shall be documented and repaired in accordance with the the's specifications and details. All field seams shall be tightly bonded on completion of the work. Any geomembrane surface showing injury due to scuffing, penetration by foreign objects or distress from other causes shall be replaced or repaired. All exposed scrim edges shall be sealed with an extrusion weld.
- B. Destructive Testing:
 - 1. Destructive test seams are to be made by each seaming crew, at the beginning of the seaming process and every four hours thereafter, or every time equipment is changed. Test seams shall be made under the same conditions as the production welds (i.e., in contact with the geomembrane subsurface and similar ambient temperature). These seams are to be made of like materials provided for the purpose of testing and not cut from the seamed panels. Each seaming crew and the materials they are using must be traceable and identifiable to their test seams. The samples shall be numbered, dated and identified as to the personnel making the seam, and the location made by appropriate notes on a print of the panel layout for the project. The completed field seam sample shall measure at least fourteen inches wide and twenty four inch long.
 - 2. The field test samples are to be tested for seam strength and peel adhesion using equipment suitable for this purpose. Shear and peel strength shall be tested in accordance with ASTM D6392. The geomembrane installer shall provide a punch press or other suitable means for the on-site preparation of the specimens for testing. The geomembrane installer shall provide a tensiometer for the on-site shear and peel testing of the samples. The tensiometer shall be in good working order, built to ASTM specifications and accompanied by evidence of recent calibration.

3. If a test sample fails to meet the field seam design specification, then the seaming crew shall make additional test samples, using the same tools, equipment, environmental conditions and materials and retest.

3.6 REPAIRS

- A. Any repairs made to the geomembrane shall be made with material supplied by the geomembrane manufacturer. For the best welding performance, the repair shall be made with newly manufactured material. Patches shall be cut with rounded corners and shall extend a minimum of four inches in all directions from the damaged area. The entire surface of the patch shall be bonded to the installed geomembrane. If reinforced material is used for the patches, the cut edges must be sealed with an extrusion weld.

3.7 COVER SOILS

- A. The fPP-R geomembrane may be covered with a geosynthetic or soil cover material in accordance with the project engineer's specifications.